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WILSON M. LAIRD, *Director*

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Stratigraphy and Structure
of
North Dakota

By

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State Geologist



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ABSTRACT

The general stratigraphy and structure of North Dakota are reviewed briefly. Maps and charts are presented showing the subsurface structure and location of important tests. Approximate figures on the present status of leasing activity are given.

STRATIGRAPHY

GENERAL

A considerable part of eastern and northern North Dakota is covered by glacial drift so that bedrock is not exposed at the surface. Of the bedrock outcropping only strata of Upper Cretaceous and Tertiary age are exposed at the surface, mainly in the northeastern part of the State and in the southwestern and western part of North Dakota. Neither the Tertiary nor the exposed Upper Cretaceous beds are particularly favorable for oil; the main possible oil bearing horizons occur in older and more deeply buried strata. These older and deeper strata are known only in a fragmentary way from study of drill cuttings of a very few wells which penetrated them and from outcrops many miles outside of North Dakota.

PRE-CAMBRIAN STRATIGRAPHY

The pre-Cambrian south and east of North Dakota consists of "granites, granite gneiss, schists and quartzites".^{1/} It has been encountered in few deep tests in the State, the Carter Company Emma L. Semling No.1 in the SE^{1/4} SE^{1/4} Section 18, T. 141 N., R. 81 W. where the pre-Cambrian was identified as an amphibolite with pyrite, the Northern Ordnance Inc. Franklin Investment Company No.1 in the NW^{1/4} SW^{1/4} Section 35, T. 133 N., R. 75 W. where the pre-Cambrian was found to be a pink granite, the Town of Grafton well in Section 13, T. 157 N., R. 53 W. where it was found to be a grey granite, and the town of Hamilton well in Section 35, T. 162 N., R. 53 W. where it was found to be a blue granite.^{2/}

PALEOZOIC STRATIGRAPHY

The main Paleozoic periods represented in the State are the Ordovician, Devonian, and Mississippian. Cambrian, Pennsylvanian, and Permian beds are also known but the beds are thin and rather poorly developed. The Silurian is doubtfully present and is thought to be found only in the northeastern corner of the State.

CAMBRIAN

The Cambrian probably is absent in eastern North Dakota but is present in the western part of the State, for a thickness of 219 feet is assigned to it in Carter's Northern Pacific No.1 well SW^{1/4} SE^{1/4} Section 19, T. 4 N., R. 62 E. Fallon County, Montana, just across the North Dakota-Montana state line.^{3/} It consists of interbedded green shale and dolomite with a basal glauconitic sandstone. The Cambrian thins progressively eastward.

ORDOVICIAN

The Ordovician is one of the most interesting and important of the Paleozoic systems represented in the State as it is one which has shown promise of being an oil-bearing horizon. In Carter's Northern Pacific No.1 in Fallon County, Montana, the Ordovician can be divided into three units, an upper series consisting of 455' of earthy and crystalline dolomite with some maroon shales and green shales, a middle series consisting of 530' grey massive granular limestone which may be equal to upper Whitewood of the Black Hills, and a lower series consisting of 605' of green sandy shale, sandy shale limestone and sandstone. The lower series may be equal to the Winnipeg sandstone or lower Whitewood.

Carter's E.L. Semling well contains a surprising thickness of 1970 feet of Ordovician. Ehlers^{4/} has divided the Ordovician into three major units. In ascending order these are the Winni-
^{1/} Seager, O.A. et. al. Discussion: Stratigraphy of North Dakota: Am. Assoc. Petroleum Geol. Bull. Vol. 26, p. 1423, 1942.

^{2/} See Laird, W.M., Selected Deep Well Records: North Dakota Geological Survey Bull. 12, 1941

^{3/} See Seager, O.A., Test on Cedar Creek Anticline, southeastern Montana: Am Assoc. Petroleum Geologists Bull. vol. 26, pp. 861-864, 1942.

^{4/} Ehlers, Allen. Williston basin wildcat test, Oliver County, North Dakota: Am. Assoc. Petroleum Geologists Bull. vol. 27, pp. 1618-1622, 1943.

FIGURE I
TABLE OF SURFACE AND SUBSURFACE FORMATIONS IN NORTH DAKOTA
By
WILSON M. LAIRD

CENOZOIC	Tertiary	Olig	White River Foramation 100-200' clays, shales, limestone, sandstone	
		Paleo- cene	Fort Union	Wasatch Group
	Sentinal Butte fm. 550' dark-colored clay, bentonite, many silicified stumps			
			Tongue River fm. 300' light-colored calcareous shale and sandstone and lignite	
			Cannonball-Ludlow fm. 0-300' marine sands, clays, Ludlow 0-250' lignite, sh. & ss.	
MESOZOIC	Cretaceous	Upper	Hell Creek fm. 100-575' grey bentonitic ss. & sh., lignitic sh. and concretions	
			Montana Group	Fox Hills 180-320' brown to grey ss. with ironstone concretions
				Pierre fm. 930-2390' grey shales and ironstone concretions
			Colorado Group	Niobrara fm. 200-250' grey sh. & "cement rock"
				Benton fm. 500-1000' dark grey shale
	Dakota fm. 15-90' micaceous white ss. with pyrite, gypsum and lignite			
	Lower	Fuson fm. 50-150' grey shale, sandy shale and sandstone		
		Lakota fm. 78-150' white sandstone with little shale		
		Jura	Morrison fm. 20-225' grey and green shale and shaly sandstone	
			Sundance fm. 150-682' glauconitic sandstone, green sh., ss. and shaly ls. with gypsum	
	Trias	Spearfish fm. 225-925' red ss. and red sh., brown ss., red sh. and evaporites		
PALEOZOIC	Permian	Minnekahta fm. 40' purple dolomite and limestone		
		Opeche fm. 88' red shale and anhydrite		
		Pa	Minnelusa fm. 0-200' white and reddish ss.	
	Mississippian	Big Snowy Group	Amsden fm. 285' orange, red, purple dol. ls. sh.	
			Heath fm. 145' black carbonaceous sh., grey to green sh., dolomite	
			Otter fm. 105' varicolored sh. and anhydrite	
			Kibbey fm. 115-285' varicolored sh. and fine grey ss. near base	
		Charles fm. 550-810' brown buff dol. limestone, grey & white anhydrite, varicolored sh.		
		Madison Group	Mission Canyon fm. 124' granular and oolitic buff ls.	
	Lodgepole fm. 633' grey to buff granular to finely crystalline ls.			
		Englewood fm. 30' carbonaceous sh., limestone, grey sh. and silstone		
	Devonian	Amaranth fm. 75-260' calcareous red sh.		
		Manitoban fm. 180-200' granular buff limestone, dol. and anhydrite		
		Winnipegosan fm. 170-216' granular and dense grey to brown ls. and dol.		
		Elm Point fm. 30-60' grey, argillaceous ls.		
	Silurian system poorly developed if found in the state			
Ordovician	Big Horn fm. 618' dense to granular buff to white dolomitic ls. and varicolored sh.			
	Upper Whitewood fm. 831' grey to tan dense to granular dolomitic and sandy ls.			
	Lower Whitewood (Winnipeg) fm. 521' green sh., conglomeratic ss., sandy ls., grey ss.			
	Cambrian 219' green sh., and dol., glauconitic ss.			
	Pre-Cambrian granite and amphibolite			

peg (521') consisting of Shale, limestone, sandstone, and conglomeratic sandstone; Red River-Whitewood formation (831') consisting of finely granular to coarse crystalline limestone and dolomitic limestone and the Stony Mountain-Bighorn formation (618') consisting of dolomitic limestone interbedded with some shale. Ehlers has subdivided the Red River-Whitewood into four units which he says are distinct markers. Oil stains and fair porosity were noted in both the Red-River-Whitewood and the overlying Stony Mountain-Bighorn formation. The latter formation Ehlers has subdivided into three units.

SILURIAN

As mentioned previously, the Silurian is in all probability either not present at all in North Dakota or found only in the northeastern part.

DEVONIAN

The Devonian of North Dakota is divided into four units which take their names from Canadian occurrences. These are in ascending order, the Elm Point limestone 30-60 feet in thickness, the Winnipegosan 170-216 feet consisting of granular dense and crystalline limestone and dolomite, the Manitoba formation 180-200 feet consisting of granular limestone with some dolomite and anhydrite and the Amaranth 75-260 feet consisting of red shales with some dolomite and anhydrite. The Winnipegosan showed fairly good porosity in the Semling well. Some possible oil stains were also found in the Manitoba formation. In the Semling well, the Elm Point formation was not differentiated. Only 95 feet of undifferentiated Devonian were logged in Northern Ordnance Franklin Investment No.1 well as contrasted to 471 feet in the Semling well.

MISSISSIPPIAN

The lowest formation of the Mississippian is the Englewood which consists of 30' of black carbonaceous shale and calcareous siltstone. Overlying the Englewood is the Madison group which consists of the Lodgepole formation and the Mission Canyon formation in ascending order. The Lodgepole consists of 600' ± of granular to dense crinoidal limestone, dense dolomitic limestone and some shale. Spirifer, Athyris and Schuchertella and other fossils are found. The Mission Canyon consists of 125 ft. ± of granular and buff oolitic limestone with some siltstones. Similar fossils to the Lodgepole are noted.

Overlying the Madison group is the Big Snowy group, one of the most interesting of the Paleozoic formations in the northern Great Plains area. In the Semling well, the Big Snowy group has a thickness of 918 feet; in the Franklin Investment well it has a thickness of 415 feet; in Carter's Northern Pacific No.1 the group is 830 feet thick. In ascending order the Big Snowy consists of the Charles (500'-800' in thickness) which is composed of buff crystalline limestone, dolomitic limestone, grey and white anhydrite, salt, and varicolored shale; the Kibbey (115'-285') consisting of varicolored shale with argillaceous sandstone toward base, the Otter (100'±) consisting of varicolored shale and some anhydrite, and the Heath (145±) consisting of carbonaceous and green shale with thin dolomite. Traces of dried oil stain were found in the basal part of the Big Snowy group.

Overlying the Big Snowy is the Amsden formation (79') which in the Semling well consists of three units, a lower gypsiferous dolomite and dolomitic sandstone, a middle green shale, and an upper finely crystalline purplish dolomite.

PENNSYLVANIAN

The Minnelusa, 0-200' of white and reddish sandstone, is the only Pennsylvanian formation in the State. It has been recognized only in the southwestern corner of North Dakota. It is not found in either the Semling or the Franklin Investment wells.

PERMIAN

The Permian is also not well represented in the State being limited to the southwestern corner in much the same area as the Pennsylvanian. The lowest Permian formation in the Opeche (88') consisting of hard dolomitic red shale with some anhydrite. The upper Permian formation is the Minnekahta (40') consisting of thin purple dolomite and limestone.

MESOZOIC STRATIGRAPHY

TRIASSIC

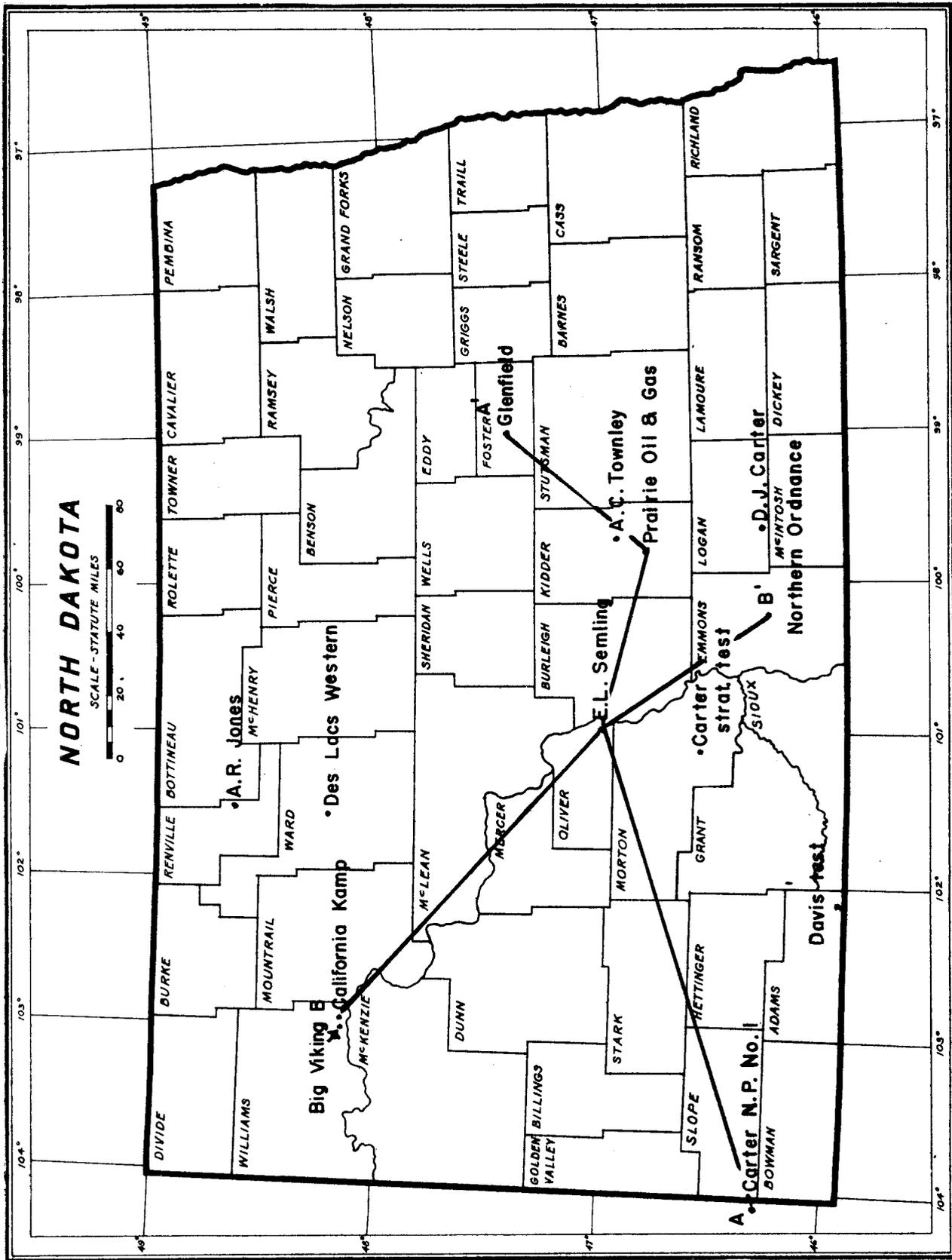
The Spearfish formation (225-925' in thickness) is the only Triassic in the northern Great Plains. It is at its thickest in North Dakota in the California Kamp No.1 well located in the NW $\frac{1}{4}$ NE $\frac{1}{4}$ Section 3, T. 154 N., R. 96 W. where it is 925 feet thick. Generally speaking, the Spearfish is divisible into two members, an upper member consisting predominantly of red argillaceous sandstone with rounded and frosted quartz grains and red shales, and a lower member of arenaceous red to brown shales with evaporites.

JURASSIC

The Jurassic is represented by two formations-the Sundance and the Morrison. The Sundance is

FIGURE 2

Sketch map showing location of important oil and gas tests in North Dakota. Location of structure sections accompanying this report are also shown.



shown in a number of wells in the State but reaches its maximum thickness in the E.L. Semling well. In the California Kamp No.1 well the Sundance consists of an upper shaly glauconitic sandstone member, a middle green shale and a lower fossiliferous sandy and shaly sandstone. The Morrison consists of 20-225 feet of grey and green shales with a few interbedded sandstones.

CRETACEOUS

The lower Cretaceous is represented by only two formations, the Lakota (78' 150') and the Fuson (50'-150'). The Lakota is a white sandstone with a little shale while the Fuson is a grey shale, sandy shale, sandstone and limestone. According to Kline^{5/} the "second and third" artesian flows of water come from the Lakota.

The Dakota is a thin bed of micaceous white quartz sandstone from 15-90 feet in thickness; It is the "first flow" of the artesian water well drillers of the state. The Dakota is here considered as the basal member of the Colorado group of the Upper Cretaceous.

Overlying the Dakota is the Benton formation which varies from 500-1000 feet increasing in thickness to the west. It is predominantly a shale sequence although some siltstone comes in to the west. In the Semling well Ehlers^{6/} has subdivided the Benton into the Graneros formation at the bottom and the Carlile formation at the top. The Graneros he further subdivides into the following members in ascending order: Skull Creek, Newcastle or Muddy, Mowry, and Belle Fourche.

The Niobrara (200'-250') consists of a dark grey calcareous shale and impure limestone containing fairly abundant microfossils particularly Foraminifera.

Overlying the Niobrara is the Pierre shale which would be the most widely exposed formation in the State were it not covered by glacial drift. It increases in thickness westward from about 930 feet in the eastern part of the State to 2390 feet in the Kamp well. The Pierre is a micaceous and bentonitic grey shale containing abundant pyrite, selenite and siderite. Pelecypods and cephalopods are common particularly in the south-central and southwestern parts of the State. Near the base of the Pierre in the Pembina Mountains in the northeastern part of North Dakota are beds of so-called "fullers earth" interbedded with the shale. This "fullers earth" is commonly yellow or light colored and makes a distinct marker in that area. Kline^{7/} found a fairly complete mososaur skeleton in these beds.

In more or less transitional contact with the Pierre is the Fox Hills formation. The Fox Hills is not completely exposed in any one section in North Dakota but its complete thickness is Corson County, South Dakota is 320'.^{8/} At its base it is a grey shale with fossiliferous concretions. Overlying the shale is the heavy greensand member. This greensand is overlain by a banded shale and sandstone sequence which is sometimes replaced by a white to grey sandstone that has been correlated with the Colgate sandstone of Montana. The Fox Hills is fossiliferous especially in the heavy greensand member.

In sharp contact with the Fox Hills is the Hell Creek formation. This formation consists of 100-575 feet of somber grey bentonitic shales and sands interbedded with thin lignites and brown lignitic shale. It thickens in a westwardly direction. Near the base of the Hell Creek is an interesting 30 foot marine bed of greenish grey sand and grey shale. With this exception the Hell Creek is entirely non-marine. Dinosaur bones are found in the Hell Creek but no well-articulated skeletons have ever been found in North Dakota. The Hell Creek is considered the latest Cretaceous formation in the State.

CENOZOIC STRATIGRAPHY

The boundary between the Cenozoic and the Cretaceous has been in controversy for many years. Recently new evidence would seem to prove that the boundary as far as North Dakota is concerned should be placed at the Hell Creek-Ludlow contact.^{9/} The Paleocene beds in North Dakota are included in the Fort Union group, which includes the Ludlow, the Cannonball, and the Tongue River formations.

The Ludlow consists of 0-250 feet of lignite and buff-colored sands and shales. It thickens as it gradually replaces the Cannonball with which it is largely contemporaneous.

The Cannonball formation consists of 0-300 feet of buff to green marine sandstones and dark grey shale. It is fossiliferous and carries a fauna which has variously been termed Cretaceous and Paleocene. Most recent work indicates a Paleocene age for these fossils. The formation is present only in the south-central and southwestern part of the State.

The Tongue River formation is composed of about 300 feet of buff calcareous sandstone, clayey

^{5/} Kline, Virginia, Stratigraphy of North Dakota: Am. Assoc. Petroleum Geologists Bull., vol.26, p. 350, 1942.

^{6/} Op. cit. p. 1619.

^{7/} Op. cit. p. 354.

^{8/} See Laird, W.M. & Mitchell, R.H., Geology of the Southern Part of Morton County, North Dakota: North Dakota Geological Survey Bull. 14, footnote p. 7, 1942.

^{9/} See Dorf, Erling, Relationship between floras of type Lance and Fort Union formations: Geol. Soc. America Bull., vol. 51, pp. 213-236, 1940. Fox, S.K. and Ross, R.J., Foraminiferal evidence for the Midway (Paleocene) age of the Cannonball formation in North Dakota: Jour. Paleontology, vol. 16, pp. 660-673, 1942.

and silty shale, lignite and lignitic shale. Volcanic ash is also present and on weathering often turns to a case-hardened quartzite. These quartzitic concretions are common where the Tongue River formation outcrops.

The Wasatch group in North Dakota consists of two formations, the Sentinal Butte shale and an "Unnamed" formation. The Sentinal Butte consists of 550 feet or more of dark-colored clays containing much bentonite. Few lignite beds are found but large numbers of silicified plant fragments and stumps are present. It is overlain by an as yet "Unnamed" formation which consists of 100 feet of large calcareous sandstone concretions interbedded in a white ashy matrix. Volcanic ash and bentonite are also present.

Unconformably overlying the Wasatch group are more or less isolated remnants of the White River formation. These beds vary in thickness from 100-200 feet and consist of shales, sandstones, bentonitic clays as well as some thin limestones. The deposits are considered to be of fluvial and lacustrine origin. A number of vertebrate fossils have been reported from these beds.^{10/}

STRUCTURE

The structural details of the subsurface geology of North Dakota, particularly the structure of the lower Mesozoic and Paleozoic rocks, are most controversial issues. The main difficulty lies in the fact that too little subsurface information is available as can be seen by the very few test yet drilled. (See Fig. 2)

Wells reaching the Dakota sandstone are relatively abundant in the southeastern part of North Dakota but few are found in the western parts of the State where the formation lies much deeper. From points plotted on the top of the Dakota, Ballard ^{11/} has prepared a structure map, a copy of which is given herewith by special permission of Mr. Ballard. The Dakota sand is used as a key bed because it is probably the most widespread single formation in the State and numerous wells have been drilled to it.

This basin in North Dakota has been called the Dakota basin or the Williston basin. By many it is regarded as the extension into North Dakota of the Lemmon syncline of South Dakota. Recently Hennen^{12/} has postulated that the axis of the Dakota basin is considerably east of what is more commonly accepted as the axis of the Dakota basin. He places the axis of the Dakota basin approximately parallel to the present course of the Missouri River. The axis of the Lemmon syncline he places west of the axis of the Dakota basin in a line running slightly west of north through a point a few miles east of Dickinson. Few geologists agree exactly with Hennen's findings at the present time. The Canadian continuation of the Dakota basin is the Moosejaw syncline.

Both the accompanying structure map and the one given by Hennen are on such small scale that many of the smaller structures do not show. The most pronounced structure in the Dakota basin is the Nesson anticline which has a closure of at least 100 feet according to Hennen's map. According to Ballard "Many of the men mapping structure in the surface rocks of the Dakotas find that there are well developed trends. The local structures, covering 6-20 square miles, with closures of 30-60 feet, occur on these trends many of which can be traced 30 miles or more. In the east-central Dakotas the surface structures trend northeast and southwest but the structures in the west third of both North Dakota and South Dakota are reported to trend west of north."^{13/}

Probably the most outstanding feature of the Dakota basin is the presence of numerous "wedge outs" of various formations, particularly those of the Mississippian, Pennsylvanian, Permian, Triassic, and Jurassic. All formations thin markedly in an eastward direction and recent tests have shown good porosity as well as oil shows particularly in the Ordovician. A good sand section in the Ordovician was encountered in both the E.L. Semling and Franklin Investment Company wells, but in the latter well saline water under considerable pressure was encountered. This water was tested by the United States Geological Survey laboratory in Casper, Wyoming, and found to contain 2607 parts per million of solids by evaporation.

Good porosity is also present in the Big Snowy and Madison groups of the Mississippian. Pennsylvanian and Permian formations do not extend very far into the State and very little is known about them.

Generally speaking, it would appear that the oil possibilities in North Dakota appear to lie in the direction of these "wedge outs" which are found mainly in the central part of the State. The correlations of the wells given in the accompanying sections are not agreed to by all geologists. The Franklin Investment well and the Prairie Oil and Gas well correlations may be subject to considerable revision at a later date when additional wells are drilled.

LEASING ACTIVITY

North Dakota has gone through several leasing campaigns. During 1937 and 1938 when the Cali-

^{10/} Leonard, A.G., The White River formation in North Dakota: Univ. of North Dakota Quat. Jour., vol. 12, pp. 218-228, 1922.

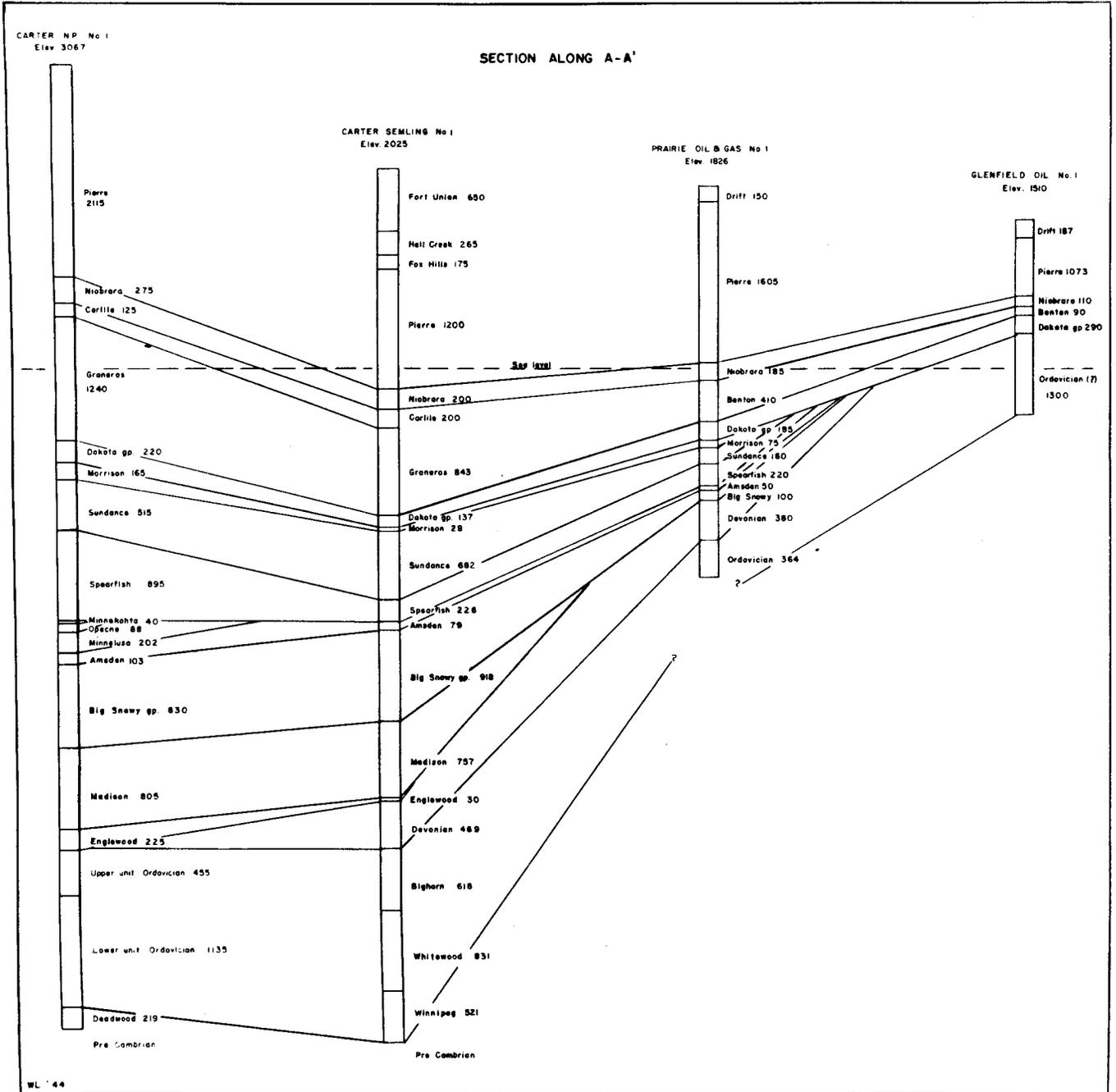
^{11/} Ballard, Norval, Regional Geology of Dakota Basin: Am. Assoc. Petroleum Geologists Bull., vol. 26, p. 1568, 1942.

^{12/} Hennen, Ray V., Tertiary geology and oil and gas prospects in the Dakota basin of North Dakota: Am. Assoc. Petroleum Geologists Bull. vol. 27, pp. 1567-1594, 1943.

^{13/} Ballard, op. cit. p. 1567, 1570.

FIGURE 4

Cross section along Line A-A'. Correlations other than the author are as follows: Carter's N.P. No.1, O.A. Seager; Carter's E.L. Semling, Allen Ehlers; Glenfield well, J.B. Reeside, Jr.



ifornia Kamp well was being drilled there were many acres leased. The most active leasing campaign is the one which was at its height during 1941. Hennen¹⁴ states that major companies had leased 2,375,000 acres and independents have leased 2,100,000 acres or a total of 4,475,000 acres. Among major operators he lists: Carter Oil Company, Magnolia Petroleum Company, Sinclair Prairie Oil Company, Stanolind Oil Company, Phillips Petroleum Company. Among the independents actively leasing he lists: Thomas W. Leach, Moser and Levorsen, Plymouth Oil Company, and Texas Canadian Oil Corporation.

Due to wartime restrictions on exploration and drilling most companies have devoted their efforts to territory which is located nearer proven acreage with the result that the play in North Dakota has died down considerably. Two unsuccessful wildcats drilled in 1942 and 1943 also discouraged operators to a certain extent.

The best available unofficial information at the present time indicates that a total of about 1,400,000 acres are still under lease. These are divided approximately as follows: Magnolia, 1,000,000; Sinclair, 100,000; Carter 25,000; Gulf, 65,000; A.M. Fruh 25,000; T.W. Leach and A.M. Fruh, 75,000; Harrison and Abercrombie, 20,000; Cities Service, 90,000; Watchorn Oil and Gas Company 20,000. Most of the land was leased on the basis of a rental of 10 cents per acre with the usual consideration of \$1.00 at time of leasing. Lands belonging to the State of North Dakota have been rented at the rate of 25 cents per acre.

NATURAL GAS PRODUCTION IN 1943

Natural gas has been known in North Dakota for a number of years. In the early 1900's gas was discovered in shallow wells in Bottineau and Ward counties. This gas was commonly found in sand underlying the glacial drift but is commonly thought as having originated either from decaying vegetation in the drift or having originated in the underlying shales from which it migrated collecting in the overlying sand. None of this area is important commercially at the present time.

The Montana-Dakota Utilities Company has 14 wells in Bowman County at the present time but not all are in production. These wells tap the Eagle sand of the Pierre shale and are located on the east flank of the Cedar Creek anticline. In 1943 they produced a total of 177,067,000 cubic feet of gas which was 55,112,000 cubic feet more than produced in 1942. New unitization agreements recently signed should increase the amount produced in 1944.

WILDCATS DRILLED PRIOR TO 1943

1. Des Lacs Western Oil Company No.1 Blum, NE¹₄ 9-155N.-85W., Ward County, Completed 1923, Elevation 1987 A.T. ground, T.D. 3980. Marker tops: Fox Hills 1300, Niobrara 3133, bottomed in Benton. Dry.

2. Davis well, NE¹₄ NW¹₄ 17-129N-91W, Adams County, Completed April 27, 1923, T.D. unknown. Little is known about this well. Apparently bottomed in Pierre with reported oil and gas shows. Log published in N.D. Geol. Survey Bull. 12 but is not regarded as reliable. Dry.

3. Glenfield Oil Company well, SE¹₄ 18-146N-62W, Foster County, Completed 1928? Elevation 1510 A.T. ground T.D. 3240. Marker tops: Pierre 187, Dakota 1460, Ordovician 1920, Pre-Cambrian 3150. Dry.

4. Prairie Oil and Gas Company's No.1 Armstrong. SW¹₄ SW¹₄ 2-140N-73W, Kidder County, Completed January 15, 1930, Elevation 1826 ground. T.D. 3884. Several correlations are available for this well. Bulletin 12 of the N.D. Geol. Survey shows Dakota 2345, Devonian 2535, Silurian 2989, Ordovician 3140, Cambrian (?) 3819. Another correlation gives Dakota 2350, Sundance 2610, Amsden 2990, Big Snowy 3040, Devonian 3140, Ordovician 3520. Ballard's correlation (A.A.P.G. Bull. vol. 26, p. 1776, 1942) Jurassic 2515 to 2770, Triassic, Permian or Pennsylvanian 2770 to 2990, Big Snowy 2988 to 3490, Pahasapa 3525 to T.D. Dry.

5. A.R. Jones Oil Operating Company's No.1 Gehringer, SE¹₄ 17-161N-84W, Renville County, Completed 1931, Elevation 1660 A.T. ground, T.D. 3872 feet. Marker tops: Dakota 3200, Jurassic 3340. Dry.

6. D.J. Carter and Company No.1 well, SE¹₄ SE¹₄ 26-134N-72W, Logan County, Completed 1934 (?) Elevation 1964 A.T. ground, T.D. 2279. Marker tops: Dakota 2091. Dry.

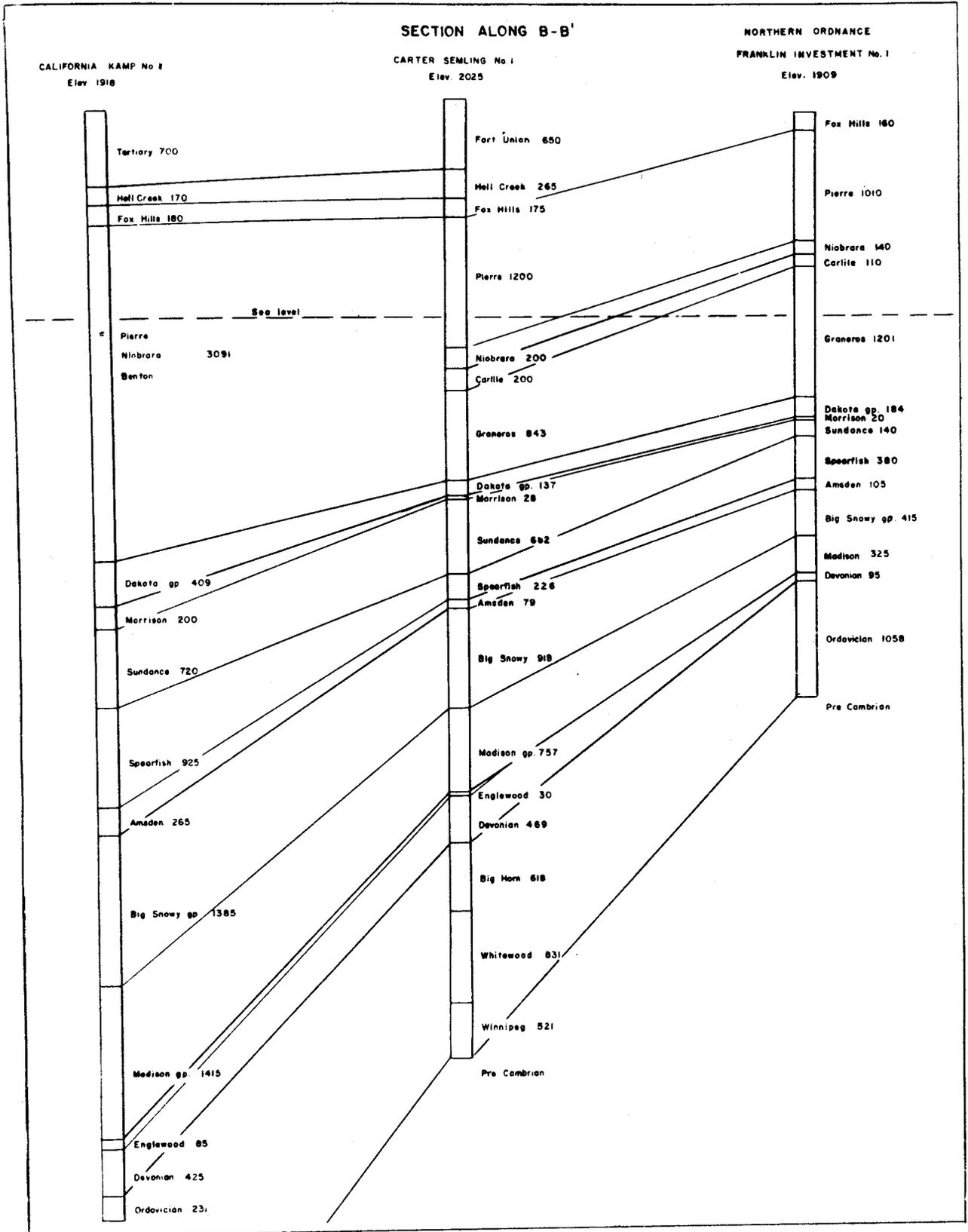
7. A.C. Townley Interests No.1 Robinson Patented land, NW¹₄ NE¹₄ 12-142N-72W, Kidder County. Completion date not known, Elevation 1800 A.T. (?) ground, T.D. 2400. Marker tops: Dakota 2275 (?). Dakota reported to have light oil show. Not too much reliance should be placed on information relative to this well. Dry.

8. Big Viking Oil Company No.1 well, NE¹₄ 3-154N-96W, Williams County, Completed spring of 1935 according to R.V. Hennen (A.A.P.G. Bull. 27, p. 1587, 1943). Elevation 1883 ground, T.D. 4642. Marker tops: Fox Hills 915, Dakota 4195. Dry.

9. California Company No.1 Kamp NW¹₄ NE¹₄ 3-154N-96W Williams County. Completed August 15, 1938 Elevation 1918 ground, 1926 rotary table, T.D. 10,281. Marker tops: (taken from R.V. Nennen, A.A. P.G. Bull. 27, p. 1588, 1943) Dakota 4221, Morrison 4630, Sundance 4830, Spearfish 5550, Amsden 6475, Big Snowy 6740, Madison 8125, Devonian 9625, Ordovician 10,050. Other authors (O.A. Seager et al. A.A.P.G. Bull. 26, p. 1421, 1942) say well ended in Devonian rather than Ordovician. Drill stem stuck and parted leaving 3000 feet in hole dry.

FIGURE 5

**Cross section along Line B-B'. Correlations other than auth-
or are as follows: California Kamp, R.V. Hennen; Carter's
E.L. Semling, Allen Ehlers.**



10. Carter Oil Company slim hole stratigraphic test, NE $\frac{1}{4}$ NW $\frac{1}{4}$ 22-136N-83W. Morton County, Completed October 1940. Elevation 2219 A.T. ground, T.D. 4930. Hennen (A.A.P.G. Bull. 27, p. 1588, 1943) reports hole stopped in Mississippian. Samples available in N.D. Geological Survey office for study but have not been studied yet. Dry.

11. Carter Oil Company's No.1 Emma L. Semling, SE $\frac{1}{4}$ SE $\frac{1}{4}$ 18-141N-81W, Oliver County, Completed August 26, 1942. Elevation 2025 A.T. ground, T.D. 8850. Marker tops: (taken from Allen Ehlers, A.A.P.C. Bull. 27, p. 1618-1622, 1943) Fox Hills 915, Dakota 3533, Morrison 3670, Sundance 3698, Spearfish 4380, Amsden 4606, Big Snowy 4685, Madison 5603, Devonian 6390, Ordovician 6861, Pre-Cambrian 8831. Dry.

WELL DRILLED IN 1943

12. Northern Ordnance Inc. No.1 Franklin Investment Company, NW $\frac{1}{4}$ SW $\frac{1}{4}$ 35-133N-75W, Emmons County, Completed July 22, 1943. Elevation 1909.5 A.T. derreck floor, T.D. 5359. Marker tops: Dakota 2621, Morrison 2805, Sundance 2825, Spearfish 2965, Big Snowy 3450, Madison 3865, Devonian 4200, Ordovician 4295, Pre-Cambrian 5353. Dry.